### AUTHOR INDEX

<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aalbersberg, I.H.</td>
<td>238</td>
</tr>
<tr>
<td>Alperna, B.</td>
<td>116</td>
</tr>
<tr>
<td>America, P.</td>
<td>227</td>
</tr>
<tr>
<td>André, F.</td>
<td>214</td>
</tr>
<tr>
<td>Apt, K.R.</td>
<td>50</td>
</tr>
<tr>
<td>Astesiano, E.</td>
<td>162</td>
</tr>
<tr>
<td>Autant, C.</td>
<td>13, 37, 239</td>
</tr>
<tr>
<td>Back, R.J.R.</td>
<td>50, 67, 136, 170</td>
</tr>
<tr>
<td>Baeten, J.C.M.</td>
<td>1, 67, 227</td>
</tr>
<tr>
<td>Bauer, F.L.</td>
<td>16, 170, 173</td>
</tr>
<tr>
<td>Becker, B.</td>
<td>44, 228</td>
</tr>
<tr>
<td>Bednarczyk, M.</td>
<td>77, 238</td>
</tr>
<tr>
<td>Belnosk, Z.</td>
<td>13, 37, 239</td>
</tr>
<tr>
<td>Bergstra, J.A.</td>
<td>1, 13, 20, 67, 127, 237, 240</td>
</tr>
<tr>
<td>Berthelot, G.</td>
<td>40, 240</td>
</tr>
<tr>
<td>Best, E.</td>
<td>12, 26, 49</td>
</tr>
<tr>
<td>Björner, D.</td>
<td>228</td>
</tr>
<tr>
<td>Bradfield, J.</td>
<td>99</td>
</tr>
<tr>
<td>Bretschneider, M.</td>
<td>227</td>
</tr>
<tr>
<td>Brooke, S.D.</td>
<td>1, 13, 15, 44, 47, 50, 124, 166</td>
</tr>
<tr>
<td>Broy, M.</td>
<td>16, 33, 170, 237</td>
</tr>
<tr>
<td>Burstall, R.M.</td>
<td>225</td>
</tr>
<tr>
<td>Campbell, R.H.</td>
<td>43, 49</td>
</tr>
<tr>
<td>Chandy, K.M.</td>
<td>1, 14, 98, 227</td>
</tr>
<tr>
<td>Chaochen, Z.</td>
<td>1, 14, 98</td>
</tr>
<tr>
<td>Clarke, E.M.</td>
<td>17, 98, 170, 240</td>
</tr>
<tr>
<td>Czajka, L.</td>
<td>49</td>
</tr>
<tr>
<td>Damm, W.</td>
<td>227</td>
</tr>
<tr>
<td>Darlington, J.</td>
<td>225</td>
</tr>
<tr>
<td>DeCicco, F.</td>
<td>49</td>
</tr>
<tr>
<td>DeMichelis, G.</td>
<td>49</td>
</tr>
<tr>
<td>DeNicola, R.</td>
<td>13, 14, 15, 50, 51, 67, 70, 71, 72, 73, 76, 77, 118, 124, 127, 166, 240</td>
</tr>
<tr>
<td>Degano, P.</td>
<td>13, 33, 50, 51, 70, 71, 72, 73, 76, 77</td>
</tr>
<tr>
<td>Dijkstra, E.W.</td>
<td>14, 16, 43, 98, 170, 171</td>
</tr>
<tr>
<td>Duque Antón, M.</td>
<td>227</td>
</tr>
<tr>
<td>Dörmen, G.</td>
<td>227</td>
</tr>
<tr>
<td>Emerson, E.A.</td>
<td>17, 98, 170, 240</td>
</tr>
<tr>
<td>Fernandez, C.</td>
<td>12, 26</td>
</tr>
<tr>
<td>Fink, A.</td>
<td>227</td>
</tr>
<tr>
<td>Francez, N.</td>
<td>15, 124, 237</td>
</tr>
<tr>
<td>Gonrich, H.</td>
<td>40</td>
</tr>
<tr>
<td>Goltz, U.</td>
<td>26, 49, 50, 67, 71, 72, 90</td>
</tr>
<tr>
<td>Graf, S.</td>
<td>99</td>
</tr>
<tr>
<td>Gries, D.</td>
<td>14, 98, 179</td>
</tr>
<tr>
<td>Gunter, C.A.</td>
<td>136</td>
</tr>
<tr>
<td>Habermann, A.N.</td>
<td>43</td>
</tr>
<tr>
<td>Harel, D.</td>
<td>20</td>
</tr>
<tr>
<td>Hehner, E.C.R.</td>
<td>16, 170</td>
</tr>
<tr>
<td>Herman, D.</td>
<td>214</td>
</tr>
<tr>
<td>Hoare, C.A.R.</td>
<td>1, 2, 13, 14, 15, 16, 20, 43, 44, 47, 50, 74, 97, 98, 124, 127, 140, 143, 146, 150, 166</td>
</tr>
</tbody>
</table>
AUTHOR INDEX

Petri, C.A., 1, 12, 13, 19, 20, 32, 33
Pichkin, G.D., 13, 19, 50, 160, 162
Puneili, A., 1, 15, 98, 123, 124
Pumello, L., 35, 49
Rabin, M.O., 19, 20
Reisig, W., 1, 12, 19, 20, 26, 31, 32, 33, 49, 240
Rem, M., 98
Rischel, H., 228
Robert, P., 214
Roocoe, A.W., 1, 13, 15, 44, 47, 50, 124, 166, 185, 186, 227
Rutten, J., 227
Rössig, S., 228, 239
Samella, D.T., 162
Schenke, M., 228, 239
Schneider, F.B., 14, 98, 116, 179
Schneebelen, P., 13, 37, 239
Scott, D.S., 15, 19, 20, 50, 136
Shields, M.W., 13, 43
Shieh, J.R., 112
Sieber, K., 136, 162, 235
Sifakis, J., 99
Simone, C., 49
Steffen, B., 99
Stirling, C., 99
Stoy, J.E., 15, 50, 136
Taratckl, A., 162
Tarski, A., 138
Teabner, D., 49, 62, 66, 71, 239
Tortigiani, P.R., 13, 43
Ullman, J.D., 24, 112, 197, 221
Vandragder, F.W., 35, 49, 50, 72, 90, 227
Verju, J.-P., 214
Waldinger, R., 225
Weijland, P., 1
Widom, J., 14, 98, 179
Winskel, G., 19, 49, 50, 72, 73, 90, 239
Wirth, N., 16, 170, 171
Wolper, P., 17, 98, 170, 240
Zucker, J.J., 50, 143
Zwiers, J., 14, 16, 98, 99, 103, 108, 111, 175, 179, 220, 240
de Bakker, J.W., 15, 44, 50, 136, 143,
AUTHOR INDEX

224, 227
de Roever, W.P., 98, 99, 171
van Emde Boas, P., 98
van Glabbeek, R.J., 35, 49, 50, 72, 90
van Wright, J., 67
van de Snepscheut, J.L.A., 98
von Wright, J., 170
SUBJECT INDEX

abstraction, 39
access control, 214
action, 20
external, 20
internal, 20
morphism, 44
aliasing, 179
alphabet, 20, 109
extended, 104
projection, 109
approximation of fixed points, 154
operational, 159
asynchrony, 54, 74
automaton, 20
abstract, 22
bisimilarity
strong, 23, 36
bisimulation
strong, 23, 36
bottom value, 101
CADIC, 44, 228
case, 28
causal
dependency, 32
net, 32
CCS, 43
choice operator
informal semantics, 47
interleaving semantics, 74
net semantics, 54, 89
readiness semantics, 141
rule, 177, 233
syntax, 45
closure
acceptance, 126
chaotic, 126
operator, 126
prefix, 126
radiation, 126
unstability, 126
coincidence
of expressions, 105
communication, 20
alphabet, 20
channel, 20, 239
initial, 175
protocol, 236
sequence, 97
trace, 101
completeness, 220
compositionality, 39, 92, 139, 144
concatenation, 99, 101
concurrency, 27, 237
auto-, 180
principle, 70
concurrent

256
SUBJECT INDEX

computation, 32, 33
processes, 1
transitions, 29
congruence
right, 221
consequence rule, 233
construction, 171
completeness, 221
context, 160
free, 44
rule, 177, 232
sensitive, 46
continuity, 137
correctness, 115
COSY, 43
counter
k-bounded, 198
1-bounded, 190
2-bounded, 193
bounded, 121
machine, 65
unbounded, 61, 122, 200
CSP, 43
deadlock, 117
freedom, 117
informal semantics, 47
net semantics, 55, 89
readiness, 140
rule, 177, 233
syntax, 45
decomposition, 51
determinism
external, 119, 133
divergence, 117
freedom, 117
informal semantics, 47
interleaving semantics, 74
net semantics, 54, 89
readiness semantics, 140
syntax, 45
embedding, 33
environment, 102, 138
technique, 139
equivalence
failure, 167
model, 161
modified readiness, 167
strong testing, 167
theorem, 159
event structure, 19, 73
expansion
equation, 222
rule, 179, 234
strategy, 197, 221
expression, 100
communication, 100
logical, 100
natural number, 100
regular, 112
trace, 100
expressiveness, 111
extensibility, 126
fairness, 236
FIFO, 214
fixed point, 137
approximation, 154
induction, 235
least, 137
technique, 139
theorem, 138
flow relation, 32
well-founded, 32
full abstraction, 160
theorem, 162
Greibach condition, 46
hiding operator
readiness semantics, 142
rule, 178, 233
syntax, 45
history
of communications, 97
variable, 110
identifier, 44
bound, 46
free, 46
independence relation, 238
interface, 114
interleaving, 25, 75

SUBJECT INDEX

case graph, 31
isomorphic
  weakly, 22, 30
isomorphism
  weakly, 22, 30
König's lemma, 118
Kleene star, 113
language, 113
  regular, 221
length
  of a trace, 99
lifting, 35
limit
  of a chain, 137
  liveness, 116, 230
marking, 28
  initial, 26
  reachable, 29
  stable, 116
  strongly well-formed, 78
  well-formed, 58
may relation, 117
mixed term, 172
  closed, 172
modal logic, 99
modularity, 197, 212
monotonicity
  of mappings, 136
  of specifications, 230
morphism
  informal semantics, 47
  interleaving semantics, 74
  net semantics, 54, 90
  syntax, 45
μ-expansion, 75
μ-notation, 44

prefix, 26
  closure, 118
  reachability, 29
POOL, 227
postset, 26
prefix closure, 118
prefix kernel, 175
prefix operator
  informal semantics, 47
  interleaving semantics, 73
  net semantics, 53, 89
  readiness semantics, 140
  rule, 177, 233
  syntax, 45
prefix relation, 101
preset, 26
priority, 45, 113
mutual exclusion, 39, 49
net, 26
  abstract, 31
  causal, 32, 33
  cyclic, 27
  finite, 61
  place/transition, 26
  safe, 30, 60
  nondeterminism, 24, 124
  normal form
    of expressions, 104
OCCAM, 227
parallel composition
  informal semantics, 47
  interleaving semantics, 74
  net semantics, 54, 89
  readiness semantics, 141
  rule, 177, 233
  syntax, 45
  partial order, 136
  complete, 137
  for readiness semantics, 139
Peano arithmetic, 111
Petri net, 26
place, 26
  reachable, 29
POOL, 227
postset, 26
prefix closure, 118
prefix kernel, 175
prefix operator
process, 1, 33
information, 125
process term, 46
  closed, 47
  nested recursive, 224
  regular, 62
projection, 102
alphabet, 109
lemma, 109
operator, 99
reachability problem, 65
readiness
domain, 125
formula, 229
logic, 229
specification, 229
readiness semantics
denotational, 142, 172
  of mixed terms, 172
  of nets, 125
  of process terms, 126
  of specifications, 134, 232
  operational, 126
ready, 116
pair, 125
set, 124
recursion
denotational semantics, 139
informal semantics, 47
interleaving semantics, 74
net semantics, 52, 58
readiness semantics, 142
  rule, 178, 234
syntax, 45
recursively enumerable, 111
regular
expression, 112
language, 221
process term, 62
relation
image, 150
pre-image, 150
pre-image finite, 150
renaming, 100
disjoint, 179, 234
renaming operator
readiness semantics, 141
  rule, 178, 233
syntax, 45, 99
retrievability, 70
retrievability principle, 70
root unwinding, 90
rule
  algebraic, 174
  construction, 174
  equation, 174
  implication, 232
  specification, 174
  transformation, 174
  transition, 53, 73
safeness, 60
safety, 115, 230
satisfaction relation
  for process terms, 115, 230
  for traces, 110
scheduling problem, 208
selection
  of a communication, 99
semantic domain, 136
  for readiness semantics, 125
  for trace logic, 101
semantic equation, 173
semantic implication, 173
semantic operator, 138
semantics
  compositional, 50, 72, 89
  denotational, 136, 138
  event structure, 73
  failure, 166
  informal, 47
  interleaving, 75
  of trace logic, 102
  operational, 50, 55, 75, 126
Petri net, 55
readiness, 125
step, 73
strong testing, 166
semaphore, 48
INDEX

transformational programming, 173

transition, 21, 26
axiom, 53
enabled, 29
global, 28
labelled, 21, 26
rule, 53
system, 20
transition relation, 26
interleaving, 73
Petri net, 53
Turing powerful, 65
UNITY, 227
validity
of trace formulas, 103
variable, 99
bound, 100
free, 100
negative occurrence, 230
positive occurrence, 230
verification, 171
completeness, 220
well-structured, 126
readiness domain, 149

sequential components, 51
complete set of, 52
decomposition into, 51
soundness, 174

theorem, 180

specification, 110
rule, 177, 233
stability, 116, 117
state, 20

initial, 21
reachability, 22
state chart, 20
state transition diagram, 21
step, 29
stepwise refinement, 171
stream, 237
subdomain, 138
substitution, 46, 100
synchronisation, 57
set, 51
synchrony, 54, 74

TCSP, 44
temporal logic, 98, 123
term, 44

action-guarded, 46
closed, 46
communication-guarded, 175
mixed, 172
process, 46
recursive, 44

theory

of trace specifications, 174
token game, 28

trace

expression, 100
formula, 100
infinite, 237
logic, 99
Mazurkiewicz-, 97
quiescent, 98
specification, 110

trace, 101
transfer property, 23, 36
transformation rule, 174
SYMBOL INDEX

In this book various sets of syntactic and semantic objects are defined. For each set we introduce some typical elements ranging over this set. For example, we introduce re as a typical element of Reg, the set of regular expressions. In this symbol index we record this by writing re ∈ Reg. In applications these typical elements may be decorated by subscripts or dashes.

**Sets and Multisets**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>{x</td>
<td>... }</td>
<td>set of all x such that “...” holds</td>
</tr>
<tr>
<td>∅</td>
<td>empty set</td>
<td>32</td>
</tr>
<tr>
<td>\N_0</td>
<td>set of natural numbers</td>
<td>34</td>
</tr>
<tr>
<td>x ∈ M</td>
<td>element of M</td>
<td>21</td>
</tr>
<tr>
<td>x ∉ M</td>
<td>not element of M</td>
<td>89</td>
</tr>
<tr>
<td>M ⊆ N</td>
<td>set and multiset inclusion</td>
<td>21, 28</td>
</tr>
<tr>
<td>M ∪ N</td>
<td>set union</td>
<td>20</td>
</tr>
<tr>
<td>M ∩ N</td>
<td>set intersection</td>
<td>38</td>
</tr>
<tr>
<td>M − N</td>
<td>set and multiset difference</td>
<td>28</td>
</tr>
<tr>
<td>M × N</td>
<td>Cartesian product</td>
<td>21</td>
</tr>
<tr>
<td>\mathcal{P}(M)</td>
<td>powerset of M</td>
<td>125</td>
</tr>
<tr>
<td>\mathcal{P}_e(M)</td>
<td>powerset of non-empty finite subsets of M</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

**Functions**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>id_M</td>
<td>identity on M</td>
<td>93</td>
</tr>
</tbody>
</table>

For a function f : A → B and a set M ⊆ A we use the following notation.
### Symbol Index

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(M)$</td>
<td>image of $M$ under $f$</td>
<td>33</td>
</tr>
<tr>
<td>$f</td>
<td>_M$</td>
<td>restriction of $f$ to $M$</td>
</tr>
</tbody>
</table>

### Languages

- $A^*$: set of finite words over $A$ (111, 221)
- $\sim_L$: right congruence of a language $L \subseteq A^*$ (221)
- $A^*/\sim_L$: congruence classes of $A^*$ under $\sim_L$ (221)
- $re \in \text{Reg}$: regular expressions (112)
- $\text{pref } re$: prefix (113)
- $\text{union } re_1 \cup re_2$: union (113)
- $\text{concatenation } re_1 \cdot re_2$: concatenation (113)
- $re^*$: Kleene star (113)
- $\mathcal{L}(re)$: language denoted by $re$ (113)

### Communications

- $a, b, c \in \text{Comm}$: communications (20)
- $A, B \subseteq \text{Comm}$: alphabets (20)
- $tr \in \text{Comm}^*$: traces (101)
- $\varepsilon \in \text{Comm}^*$: empty trace (101)
- $tr_1 \cdot tr_2$: concatenation (101)
- $\text{prefix relation } tr_1 \leq tr_2$: prefix relation (101)
- $u, v, w \in \text{Act}$: actions (20)
- $\tau \in \text{Act}$: internal action (20)

### Automata

- $\mathcal{A} = (A, S_I, \rightarrow, q_0)$: automaton (20)
- $p, q, \tau \in S_I$: states (20, 21)
- $q_0 \in S_I$: initial state (21)
- $p \rightarrow u$: transition (21)
- $\text{reach}(\mathcal{A})$: reachable states (22)
- $\mathcal{A}_1 = \text{iso}\mathcal{A}_2$: weakly isomorphic (22)
- $\mathcal{A}$: abstract automaton (22)
- $\mathcal{A}_1 \approx \mathcal{A}_2$: strongly bisimilar (23)
- $B \subseteq S_I \times S_I$: strong bisimulation (23)
- $\mathcal{A}(N)$: interleaving case graph of a net (31)
- $P \rightarrow u \rightarrow Q$: interleaving transition (73)
- $\mathcal{A}[P]$: operational interleaving semantics (75)
**SYMBOL INDEX**

263

**PETRI NETS**

\[ N = (A, P_l, \rightarrow, M_0) \]  
Petri net  

\[ p, q, r \in P_l \]  
places  

\[ M, N \]  
markings  

\[ M_0 \subseteq P_l \]  
initial marking  

\[ wf \]  
well-formed (marking)  

\[ swf \]  
strongly well-formed (marking)  

\[ next(M) \]  
next actions  

\[ upd(M) \]  
update operation  

\[ t = t^u \rightarrow O \]  
net transition  

\[ t \in \rightarrow \]  
transitions  

\[ T \subseteq \rightarrow \]  
global transitions  

\[ \text{pre}(t), \text{pre}(T), \text{pre}(p) \]  
preset  

\[ \text{act}(t), \text{act}(T) \]  
action  

\[ \text{post}(t), \text{post}(T), \text{post}(p) \]  
postset  

\[ \mathcal{F}_N \]  
flow relation  

\[ M \xrightarrow{t} M' \]  
transition execution  

\[ M \xrightarrow{\text{tr}} M' \]  
concurrent transition execution, step  

\[ M \xrightarrow{\text{tr}} M' \]  
exeuction of a trace  

\[ \text{mark}(N) \]  
reachable markings  

\[ \text{place}(N) \]  
statically reachable place  

\[ N_1 \equiv \text{serm. } N_2 \]  
weakly isomorphic  

\[ [N] \]  
abstract net  

\[ N_1 \equiv \text{serm. } N_2 \]  
set of abstract nets  

\[ B \subseteq P_l \times P_l \]  
strong bisimulation on places  

\[ \mathcal{B} \]  
lifting  

\[ N_1 \equiv N_2 \]  
strongly bisimilar  

**PROCESS TERMS**

\[ X, Y, Z \in \text{Idf} \]  
identifiers  

\[ \text{Idf}: A \]  
identifiers of alphabet \( A \)  

\[ \varphi: \text{Act} \rightarrow \text{Act} \]  
action morphisms  

\[ E, Q, R \in \text{Rec} \]  
recursive terms  

\[ C(X) \in \text{Rec} \]  
context  

\[ \text{Proc} \subseteq \text{Rec} \]  
process terms  

\[ \text{CProc} \]  
closed process terms  

\[ \text{RegProc} \]  
regular process terms  

\[ \text{stop}: A \]  
deadlock  

\[ \text{div}: A \]  
divergence  

\[ a.P \]  
prefix operator
### Symbol Index

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P + Q$</td>
<td>choice operator</td>
<td>45</td>
</tr>
<tr>
<td>$P</td>
<td>Q$</td>
<td>parallel composition</td>
</tr>
<tr>
<td>$P[\varphi]$</td>
<td>morphism</td>
<td>45</td>
</tr>
<tr>
<td>$\mu X. P$</td>
<td>recursion</td>
<td>45</td>
</tr>
<tr>
<td>$\Sigma^n \in P$</td>
<td>general choice</td>
<td>45</td>
</tr>
<tr>
<td>$\Sigma^n \in P$</td>
<td>general parallelism</td>
<td>45</td>
</tr>
<tr>
<td>$P[b_1, \ldots, b_n, a_1, \ldots, a_m]$</td>
<td>renaming operator</td>
<td>45</td>
</tr>
<tr>
<td>$P_1 \setminus P_2$</td>
<td>hiding operator</td>
<td>45</td>
</tr>
<tr>
<td>$P_1 \setminus P_2$</td>
<td>renaming operator</td>
<td>45</td>
</tr>
<tr>
<td>$P[Q/X]$</td>
<td>simultaneous substitution</td>
<td>46</td>
</tr>
<tr>
<td>$\alpha(P)$</td>
<td>alphabet</td>
<td>46</td>
</tr>
<tr>
<td>$\omega$</td>
<td>alphabet operators</td>
<td>47</td>
</tr>
<tr>
<td>$\mu$</td>
<td>$\mu$-expansion</td>
<td>75</td>
</tr>
<tr>
<td>$\delta(P)$</td>
<td>decomposition and expansion</td>
<td>51</td>
</tr>
</tbody>
</table>

### Net Semantics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C, D \in \text{Sequ}$</td>
<td>sequential components</td>
<td>51</td>
</tr>
<tr>
<td>$P, Q, R \subseteq \text{Sequ}$</td>
<td>sets of sequential components</td>
<td>51</td>
</tr>
<tr>
<td>$C \setminus \alpha. P \parallel \alpha Q$</td>
<td>left part of parallel composition</td>
<td>51</td>
</tr>
<tr>
<td>$\parallel \alpha D, \parallel \alpha Q$</td>
<td>right part of parallel composition</td>
<td>51</td>
</tr>
<tr>
<td>$C + D, P + Q$</td>
<td>choice</td>
<td>51</td>
</tr>
<tr>
<td>$C[\varphi], P[\varphi]$</td>
<td>morphism</td>
<td>51</td>
</tr>
<tr>
<td>$\delta(P)$</td>
<td>decomposition and expansion</td>
<td>51</td>
</tr>
<tr>
<td>$\gamma(P)$</td>
<td>syntactic complexity</td>
<td>52</td>
</tr>
<tr>
<td>$\alpha(P)$</td>
<td>alphabet</td>
<td>52</td>
</tr>
<tr>
<td>$P \longrightarrow u Q$</td>
<td>net transition</td>
<td>53</td>
</tr>
<tr>
<td>$N[P]$</td>
<td>operational net semantics</td>
<td>55</td>
</tr>
<tr>
<td>$\alpha(P)$</td>
<td>transition relation restricted to $\alpha(P)$</td>
<td>55</td>
</tr>
<tr>
<td>$\alpha(P)$</td>
<td>compositional net operators for</td>
<td>89</td>
</tr>
<tr>
<td>$\text{stop}:A_N$</td>
<td>... deadlock</td>
<td>89</td>
</tr>
<tr>
<td>$\text{div}:A_N$</td>
<td>... divergence</td>
<td>89</td>
</tr>
<tr>
<td>$a_N, N_0$</td>
<td>... prefix</td>
<td>89</td>
</tr>
<tr>
<td>$[N_1] +_N [N_2]$</td>
<td>... choice</td>
<td>89</td>
</tr>
<tr>
<td>$[N_1] [N_2]$</td>
<td>... parallel composition</td>
<td>89</td>
</tr>
<tr>
<td>$[N_0] [\varphi]_N$</td>
<td>... morphism</td>
<td>90</td>
</tr>
</tbody>
</table>

### Logical Formulas

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t, h \in \text{Var}$</td>
<td>trace variables</td>
<td>99, 110</td>
</tr>
<tr>
<td>$C, H \in \text{Var}$</td>
<td>set variables</td>
<td>229</td>
</tr>
<tr>
<td>$n \in \text{Var}$</td>
<td>natural number variables</td>
<td>99</td>
</tr>
</tbody>
</table>
### SYMBOL INDEX

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$xe \in Exp$</td>
<td>expressions</td>
<td>100</td>
</tr>
<tr>
<td>$xe{te/t}$</td>
<td>substitution</td>
<td>100</td>
</tr>
<tr>
<td>$xe{te_{1}, ..., te_{n}/t_{1}, ..., t_{n}}$</td>
<td>simultaneous substitution</td>
<td>100</td>
</tr>
<tr>
<td>$xe{b/a}$</td>
<td>renaming</td>
<td>100</td>
</tr>
<tr>
<td>$xe{b_{1}, ..., b_{n}/a_{1}, ..., a_{n}}$</td>
<td>simultaneous renaming</td>
<td>100</td>
</tr>
<tr>
<td>$xe_{norm}$</td>
<td>normal form</td>
<td>104</td>
</tr>
<tr>
<td>$\alpha(xe)$</td>
<td>(projection) alphabet</td>
<td>109</td>
</tr>
<tr>
<td>$aa(xe)$</td>
<td>extended alphabet</td>
<td>104</td>
</tr>
<tr>
<td>$te ∈ Exp : trace$</td>
<td>trace expressions</td>
<td>100</td>
</tr>
<tr>
<td>$te_{1}.te_{2}$</td>
<td>concatenation</td>
<td>100</td>
</tr>
<tr>
<td>$te[A]$</td>
<td>projection operator</td>
<td>100</td>
</tr>
<tr>
<td>$te[b/a]$</td>
<td>renaming operator</td>
<td>100</td>
</tr>
<tr>
<td>$se ∈ Exp : set$</td>
<td>set expressions</td>
<td>229</td>
</tr>
<tr>
<td>$ne ∈ Exp : nat$</td>
<td>natural number expressions</td>
<td>100</td>
</tr>
<tr>
<td>$</td>
<td>te</td>
<td>_e$</td>
</tr>
<tr>
<td>$a#te$</td>
<td>number of a’s in $te$</td>
<td>112</td>
</tr>
<tr>
<td>$ne_{1} + ne_{2}$</td>
<td>addition</td>
<td>100</td>
</tr>
<tr>
<td>$ne_{1} \cdot ne_{2}$</td>
<td>multiplication</td>
<td>100</td>
</tr>
<tr>
<td>$ce ∈ Exp : comm$</td>
<td>communication expressions</td>
<td>100</td>
</tr>
<tr>
<td>$te[ne]$</td>
<td>$ne$-th element of $te$</td>
<td>100</td>
</tr>
<tr>
<td>$\text{first } te$</td>
<td>first element of $te$</td>
<td>112</td>
</tr>
<tr>
<td>$\text{last } te$</td>
<td>last element of $te$</td>
<td>112</td>
</tr>
<tr>
<td>$le ∈ Exp : log$</td>
<td>logical expressions, trace formulas</td>
<td>100</td>
</tr>
<tr>
<td>$te_{1} ≤ te_{2}$</td>
<td>prefix relation</td>
<td>100</td>
</tr>
<tr>
<td>$se_{1} ⊆ se_{2}$</td>
<td>set inclusion</td>
<td>229</td>
</tr>
<tr>
<td>$-le$</td>
<td>negation</td>
<td>100</td>
</tr>
<tr>
<td>$le_{1} \land le_{2}$</td>
<td>conjunction</td>
<td>100</td>
</tr>
<tr>
<td>$le_{1} \lor le_{2}$</td>
<td>disjunction</td>
<td>112</td>
</tr>
<tr>
<td>$le_{1} → le_{2}$</td>
<td>implication</td>
<td>112</td>
</tr>
<tr>
<td>$\exists le_{1} : le_{2}$</td>
<td>equivalence</td>
<td>112</td>
</tr>
<tr>
<td>$\forall le_{1} : le_{2}$</td>
<td>existential quantification</td>
<td>100</td>
</tr>
<tr>
<td>$\exists le_{1} : le_{2}$</td>
<td>universal quantification</td>
<td>112</td>
</tr>
<tr>
<td>$\forall le_{1} : le_{2}$</td>
<td>relatived quantification</td>
<td>112</td>
</tr>
<tr>
<td>$\forall le_{1} : le_{2}$</td>
<td>relatived quantification</td>
<td>112</td>
</tr>
<tr>
<td>$\forall le_{1} : le_{2}$</td>
<td>general conjunction</td>
<td>112</td>
</tr>
<tr>
<td>$≤$</td>
<td>interpretation of trace logic</td>
<td>101</td>
</tr>
<tr>
<td>$ρ ∈ Env_{o}$</td>
<td>environments</td>
<td>102</td>
</tr>
<tr>
<td>$ρ[tr/t], ρ[k/n]$</td>
<td>update of environments</td>
<td>103</td>
</tr>
<tr>
<td>$\exists xe_{1}(ρ)$</td>
<td>standard semantics of expressions</td>
<td>102, 103</td>
</tr>
<tr>
<td>$\perp le$</td>
<td>special semantic value (bottom)</td>
<td>101</td>
</tr>
<tr>
<td>$\models le$</td>
<td>validity of trace formulas</td>
<td>103</td>
</tr>
</tbody>
</table>
### Trace Specifications and Mixed Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S, T \in \text{Spec}$</td>
<td>trace specifications</td>
<td>110</td>
</tr>
<tr>
<td>$\alpha(S)$</td>
<td>(projection) alphabet</td>
<td>110</td>
</tr>
<tr>
<td>$\alpha\alpha(S)$</td>
<td>extended alphabet</td>
<td>110</td>
</tr>
<tr>
<td>$tr \models S$</td>
<td>satisfaction relation for traces</td>
<td>110</td>
</tr>
<tr>
<td>$\text{pref } tr \models S$</td>
<td>... and all their prefixes</td>
<td>116</td>
</tr>
<tr>
<td>$P \models S$</td>
<td>satisfaction relation for process terms</td>
<td>115</td>
</tr>
<tr>
<td>$\text{kernel}(S)$</td>
<td>kernel</td>
<td>175</td>
</tr>
<tr>
<td>$\text{init}(S)$</td>
<td>initial communications</td>
<td>175</td>
</tr>
<tr>
<td>$\text{Th}($Spec$)$</td>
<td>theory of trace specifications</td>
<td>174</td>
</tr>
<tr>
<td>$P, Q, R \in \text{Proc} + \text{Spec}$</td>
<td>mixed terms</td>
<td>172</td>
</tr>
<tr>
<td>$\text{CP} \text{Proc} + \text{Spec}$</td>
<td>closed mixed terms</td>
<td>172</td>
</tr>
</tbody>
</table>

### Readiness Semantics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mathcal{R}$</td>
<td>readiness semantics</td>
<td>124</td>
</tr>
<tr>
<td>$\mathcal{R}^*$</td>
<td>modified readiness semantics</td>
<td>124</td>
</tr>
<tr>
<td>$\gamma, \delta \in \text{Info}_R : A$</td>
<td>process information</td>
<td>125</td>
</tr>
<tr>
<td>$\Gamma, \Delta \in \text{Info}_R : A$</td>
<td>sets of process information</td>
<td>125</td>
</tr>
<tr>
<td>$(A, \Gamma), (B, \Delta) \in \text{DOM}_R$</td>
<td>readiness domain</td>
<td>125</td>
</tr>
<tr>
<td>$\text{ws-DOM}_R$</td>
<td>well-structured readiness domain</td>
<td>149</td>
</tr>
<tr>
<td>$\alpha(A, \Gamma)$</td>
<td>alphabet part</td>
<td>125</td>
</tr>
<tr>
<td>$\pi(A, \Gamma)$</td>
<td>process information part</td>
<td>125</td>
</tr>
<tr>
<td>$\text{close}(A, \Gamma)$</td>
<td>closure operator</td>
<td>126</td>
</tr>
<tr>
<td>$\text{succ}(tr, \Gamma)$</td>
<td>successor communications</td>
<td>126</td>
</tr>
<tr>
<td>$\mathcal{F}, \mathcal{G}, \mathcal{H}$</td>
<td>ready sets</td>
<td>125</td>
</tr>
<tr>
<td>$\mathcal{X} \subseteq \text{Comm} \cup {1}$</td>
<td>ready sets or divergence symbol</td>
<td>125</td>
</tr>
<tr>
<td>$\mathcal{R}'(\mathcal{N})$</td>
<td>readiness semantics of nets</td>
<td>125</td>
</tr>
<tr>
<td>$\mathcal{R}'[P]$</td>
<td>(operational) readiness semantics of process terms</td>
<td>126</td>
</tr>
<tr>
<td>$\mathcal{R}'[S]$</td>
<td>readiness semantics of trace specifications</td>
<td>134</td>
</tr>
<tr>
<td>$x \subseteq y$</td>
<td>partial order</td>
<td>136</td>
</tr>
<tr>
<td>$\bot$</td>
<td>least element (bottom)</td>
<td>138</td>
</tr>
<tr>
<td>$\bot_D$</td>
<td>least upper bound</td>
<td>136</td>
</tr>
<tr>
<td>$\xi \tau_\Phi$</td>
<td>limit of a chain</td>
<td>137</td>
</tr>
<tr>
<td>$\text{fix} \Phi$</td>
<td>fixed point of $\Phi$</td>
<td>137</td>
</tr>
<tr>
<td>$\Phi^n$</td>
<td>$n$-fold iteration of $\Phi$</td>
<td>138</td>
</tr>
<tr>
<td>$\rho \in \text{Env}_{\text{DA}}$</td>
<td>environments</td>
<td>138</td>
</tr>
<tr>
<td>$\mathcal{R}''<a href="%5Crho">P</a>$</td>
<td>denotational readiness semantics of process terms</td>
<td>142</td>
</tr>
<tr>
<td>$\text{op}_R$</td>
<td>readiness operators for</td>
<td>140</td>
</tr>
<tr>
<td>$\text{stop} : A_R$</td>
<td>... deadlock</td>
<td>140</td>
</tr>
<tr>
<td>$\text{div} : A_R$</td>
<td>... divergence</td>
<td>140</td>
</tr>
<tr>
<td>Symbol</td>
<td>Meaning</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>$a_</td>
<td></td>
<td></td>
</tr><tr>
<td>ho(A, \Gamma)$</td>
<td>prefix</td>
<td>140</td>
</tr>
<tr>
<td>$(A, \Gamma) +\rho (B, \Delta)$</td>
<td>choice</td>
<td>141</td>
</tr>
<tr>
<td>$(A, \Gamma)/\rho (B, \Delta)$</td>
<td>parallel composition</td>
<td>141</td>
</tr>
<tr>
<td>$(A, \Gamma)[b/a]_\rho$</td>
<td>renaming</td>
<td>141</td>
</tr>
<tr>
<td>$(A, \Gamma)\setminus b_\rho$</td>
<td>hiding</td>
<td>142</td>
</tr>
<tr>
<td>$P \equiv_{sat} Q$</td>
<td>satisfaction equivalence</td>
<td>160</td>
</tr>
<tr>
<td>$P \equiv_{M} Q$</td>
<td>model equivalence</td>
<td>161</td>
</tr>
<tr>
<td>$P \equiv_{R^e} Q$</td>
<td>modified readiness equivalence</td>
<td>167</td>
</tr>
<tr>
<td>$P \equiv_{F} Q$</td>
<td>failure equivalence</td>
<td>167</td>
</tr>
<tr>
<td>$P \equiv_{S} Q$</td>
<td>strong testing equivalence</td>
<td>167</td>
</tr>
<tr>
<td>$P \equiv_{\Rightarrow} Q$</td>
<td>semantic implication</td>
<td>173</td>
</tr>
<tr>
<td>$P \equiv Q$</td>
<td>semantic equation</td>
<td>173</td>
</tr>
</tbody>
</table>